

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

EFFECTIVE DATE: August 24, 1995

EDITION NO.: 1

MANUFACTURER AND MODEL:

Make: *Niton Corporation*
Model: *XL-309 Spectrum Analyzer*
Source: *Cd¹⁰⁹*
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, source, and software versions shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted March 1995 on approximately 150 test locations using a single instrument with an October 1994 source at 10 mCi initial strength while running software version 1.2C. These results supersede the 1993 testing of XL prototypes reported in the document titled: *A Field Test of Lead-Based Paint Testing Technologies*.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 20-second readings for L-shell results or 120-second readings for K-shell results on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm²) NIST Standard Reference Material (SRM No. 2579) paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm².

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XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. If the observed calibration check average minus 1.02 mg/cm² is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.1 mg/cm²
plus value = +0.1 mg/cm²

FOR XRF RESULTS BELOW 4.0 mg/cm², SUBSTRATE CORRECTION RECOMMENDED FOR:

None

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

HOW TO CLASSIFY READINGS:

This section describes how to apply the readings and other information displayed by this instrument to determine the presence or absence of lead in paint using the procedures recommended in Chapter 7 of the HUD Guidelines. These guidelines recommend classifying XRF results as positive, negative, or inconclusive compared to the 1.0 mg/cm² standard. But because this instrument displays readings and ancillary information useful for classification purposes, an algorithmic procedure is described that makes use of not only the XRF reading but some of the other displayed information as well.

As detailed below, the algorithm for classifying results is first applied to 20-second nominal L-shell readings followed by 120-second nominal K-shell readings to resolve inconclusive results and laboratory analysis of paint-chip samples, if necessary. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to perform additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

XRF results are classified using threshold values. For the XL-309, threshold values are the only values provided for classifying results. Results are classified as positive if they are greater than or equal to the threshold, and as negative if they are less than the threshold. There is no inconclusive classification when using threshold values. However, inconclusive results still may be obtained regardless of whether decisions are based on L-shell readings, K-shell readings, or both, as described below. Use all digits that are reported by the instrument. Threshold values, which were determined for comparing results to the 1.0 mg/cm² standard, are provided in the following table.

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DESCRIPTION	SUBSTRATE	THRESHOLD* (mg/cm ²)
Results not corrected for substrate bias	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0
*Application of the decision making methodology recommended in this PCS can result in inconclusive results regardless of whether decisions are based on L-shell readings, K-shell readings, or both.		

This instrument displays its lead-based paint measurements as both L-shell and K-shell readings based on the corresponding L-shell and K-shell X-ray fluorescence (refer to Chapter 7 of the HUD Guidelines for more details). The L-shell readings (or L-readings) are displayed as a numerical result alone, or as a numerical result preceded by either one greater-than symbol ">" or preceded by two greater-than symbols ">>". The two greater-than symbols will only be displayed when the detected lead level is greater than 5.0 mg/cm². Since the maximum lead level reported by this instrument is 5.0 mg/cm², lead levels greater than 5.0 mg/cm² are displayed as ">>5.0". Other examples of how L-readings can be displayed (in mg/cm² units) are "0.6" and ">0.9". The numerical display alone implies that the instrument measured the lead in the paint at the displayed level using L-shell X-ray fluorescence; 0.6 mg/cm² in the example. A number preceded by a single greater-than symbol indicates that the measurable lead is deeply buried in the paint and the detected lead level is greater than the displayed value. In the example, >0.9 indicates that the instrument detected lead deeply buried in paint at a level greater than 0.9 mg/cm². K-shell readings (or K-readings) are displayed in one of two ways: 1) as a single K-reading plus and minus a "precision" value or 2) as an upper K-reading and lower K-reading.

The algorithm used for testing in multifamily housing differs slightly from that used in single-family housing. This is because the recommended number of readings per testing combination varies between the two types of housing. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, the HUD Guidelines recommend taking a single XRF reading on a testing combination. In single-family housing, three XRF readings are recommended on each testing combination.

MULTIFAMILY HOUSING XRF RESULT CLASSIFICATIONS:

- A. Take a single 20-second nominal reading on each testing combination.
- B. Classify the L-reading based on the type of information displayed.

If two greater-than symbols are displayed then:

- Classify the >>5.0 L-reading as POSITIVE

If one greater-than symbol is displayed then:

- Classify the L-reading as POSITIVE if the numerical result that follows the greater than symbol is equal to or greater than 1.0.

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- Classify the L-reading as INCONCLUSIVE if the numerical result that follows the greater than symbol is less than 1.0.

If the numerical L-reading is displayed alone (that is, without any preceding greater-than symbols) then:

- Classify the L-reading as POSITIVE if the numerical result is equal to or greater than 1.0.
- Classify the L-reading as NEGATIVE if the numerical result is less than 1.0.

C. Resolution of results classified as inconclusive.

All results classified as inconclusive above require further investigation. Take a 120-second nominal XRF reading and use the K-shell reading. In multifamily housing, resolve the inconclusive classification with a single K-shell reading or laboratory analysis as described below.

- Classify the result as POSITIVE if either the K-reading minus the displayed precision value or the lower K-reading is equal to or greater than 1.0.
- Classify the result as NEGATIVE if either the K-reading plus the displayed precision value or the upper K-reading is less than 1.0.
- Classify the result as INCONCLUSIVE if neither of the above decision rules using the K-reading provided a classification which can occur when the upper K-reading is equal to or greater than 1.0 or the lower K-reading is less than 1.0.
- To resolve a remaining INCONCLUSIVE classification, remove a paint-chip sample and have it analyzed in a laboratory as described in Chapter 7 of the HUD Guidelines.

SINGLE-FAMILY HOUSING XRF RESULT CLASSIFICATIONS:

- D. Take three 20-second nominal readings on each testing combination.
- E. Classify each L-reading using the methodology described in item A under Multifamily Housing XRF Result Classifications.
- F. Classification of the XRF result for a given testing combination is obtained by combining the individual results of the three L-shell readings as follows:
- A POSITIVE classification is obtained if at least two of the three individual L-readings are classified as positive.
 - A NEGATIVE classification is obtained if at least two of the three individual L-readings are classified as negative.
 - An INCONCLUSIVE classification is obtained if at least two of the three individual L-readings are classified as inconclusive or if one L-reading is classified as positive, another is classified

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as negative, and the third is classified as inconclusive.

G. Resolution of results classified as inconclusive.

Any results classified as inconclusive require further investigation in the same manner as described above for multifamily housing with one exception. Take three 120-second nominal K-readings instead of a single one. Obtain a classification by combining the individual results of the three K-readings. Resolve the inconclusive classification by classifying the combined K-shell readings or with laboratory analysis as described below.

- A POSITIVE classification is obtained if at least two of the three individual K-readings were classified as positive.
- A NEGATIVE classification is obtained if at least two of the three individual K-readings were classified as negative.
- An INCONCLUSIVE classification is obtained if at least two of the three individual K-readings were classified as inconclusive.
- To resolve a remaining INCONCLUSIVE classification, remove a paint-chip sample and have it analyzed in a laboratory as described in Chapter 7 of the HUD Guidelines.

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Use the 20-second L-shell readings, ignoring the ">" and ">>" symbols that precede the displayed readings if they occur.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

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Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

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BIAS AND PRECISION:

These bias and precision data were computed without substrate correction using the using 20-second L-shell readings from samples with reported laboratory results less than 4.0 mg/cm² lead. Readings reported by the instrument in the ">x" or ">>x" format were not used in the computation. There were 15 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm² lead. Of these, 12 readings were reported in the ">x" or ">>x" format, but of the 3 remaining, 1 had an XRF reading less than 1.0 mg/cm². These data are for illustrative purposes only. Substrate correction is not recommended for this XRF instrument. Units are in mg/cm².

MEASURED AT	SUBSTRATE	BIAS (mg/cm ²)	PRECISION* (mg/cm ²)
0.0 mg/cm ²	All	0.0	<0.1
0.5 mg/cm ²	All	0.0	0.2
1.0 mg/cm ²	All	0.0	0.3
2.0 mg/cm ²	All	-0.1	0.5
*Precision at 1 standard deviation			

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.